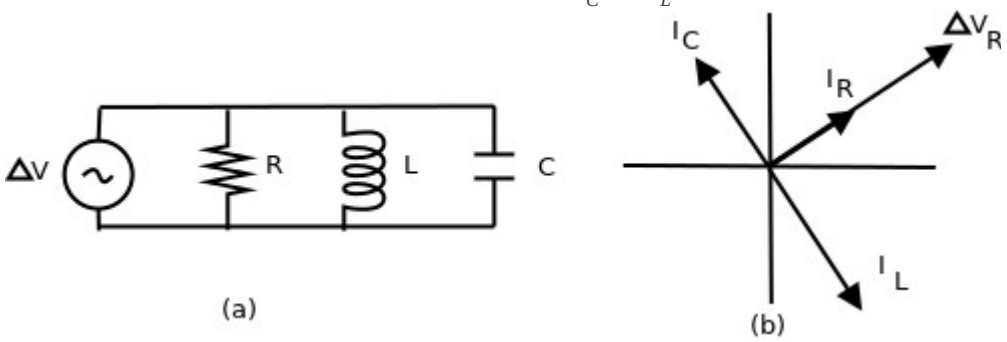
Phys 2201 – Electricity and Magnetism
Homework #19 – Due Thursday, March 29, 2016 by 3pm
(hand in to drop box outside 3L24)

1. The figure below shows a parallel RLC circuit in panel (a) and the corresponding phasor diagram in panel (b). Note that the instantaneous voltage across each of the circuit elements is the same, and is in phase with the current through the resistor.

   (a) Show that the RMS current delivered by the source is: $I_{rms} = \Delta V_{rms}\sqrt{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2}$.

   (b) Show that the phase angle between the source ΔV_{rms} and I_{rms} is:

$$\tan\varphi = R\left(\frac{1}{X_C} - \frac{1}{X_L}\right)$$

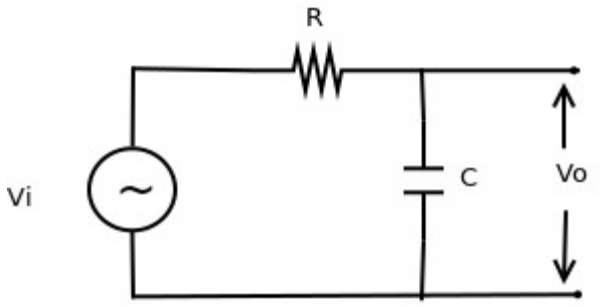


2. Consider the filter circuit below.

   (a) What is the ratio of output voltage to input voltage $H(\omega) = \frac{\Delta V_o}{\Delta V_i}$ as a function of angular frequency (in terms of ω,R, and C)?

   (b) If R = 220 Ohms, and C = 1.2 uF, at what frequency f, will the amplitude of the output voltage be half of the input?

   (c) Sketch H(ω) versus ω.

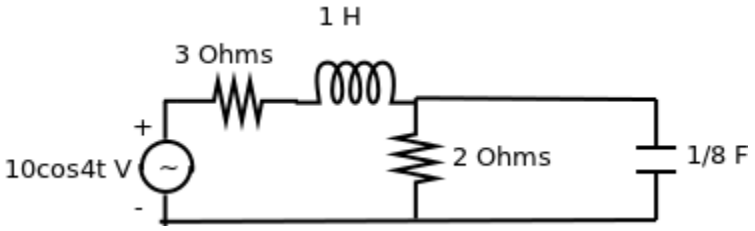


(d) Determine the phase angle $\varphi(\omega)$ of the output voltage, relative to the input voltage, as a function of frequency (in terms of ω, R, and C).

(e) What is the phase angle for R = 220, and C = 1.2 uF, for the frequency at which $H(\omega) = 1/2$?

(f) Sketch $\varphi(\omega)$ versus ω.

3. Find the average power dissipated by the 2 Ohm resistor in the circuit below.



3. Consider an RLC series circuit connected to an AC voltage source.
(a) Use Kirchhoff's rules to write down the differential equation in charge in terms of R, L, C, and an AC voltage V.
(b) Determine the complex impedance seen by the AC voltage source in terms of R,L, and C.
(c) Determine the amplitude of the current in terms of the voltage amplitude (V_{max}), R, L, and C.
(d) What is the resonant frequency, f (in Hertz), when L=50 μH, C=400pF?
(e) Sketch the current amplitude versus ω/ω_0 for V_{max} = 1.0 V, and R=100 Ohms, including $\omega/\omega_0=\{0.95, 0.98, 1.0, 1.02, 1.05\}$. (Hint: it should be symmetric about $\omega/\omega_0=1$).
(f) On the same sketch as (e), sketch the current amplitude versus ω/ω_0 for V_{max}=1.0V, and R= 5 Ohms, including $\omega/\omega_0=\{0.95, 0.98, 1.0, 1.02, 1.05\}$.

4. The AC generator in the figure below supplies 110 V (RMS) at 50 Hz. With the switch open as in the diagram, the resulting current leads the generator Emf by 25°. With the switch in position 1, the current lags the generator Emf by 10°. When the switch is in position 2, the rms current is 1.9 A. What are the values of R, L, and C.